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Fact sheet

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Managing Soil pH for Turfgrasses

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The soils of the humid, northeastern region of the United States are naturally acidic except where soils have developed over limestone parent material. The amount of annual rainfall largely determines whether soils will become acid, neutral, or alkaline. In regions of high rainfall, such as New Jersey, the alkaline elements in the soil are slowly replaced by hydrogen ions from the water and are leached deep into the lower horizons of the soil. This weathering process leads to the development of an acid soil. Conversely, soils which develop under conditions of low rainfall, such as the arid Southwest, tend to become alkaline. The use of certain fertilizers, acid rains, and clipping removal of the alkaline elements also contribute to the development of soil acidity.

Soil pH

Acidity and alkalinity are defined in terms of the hydrogen ion concentration found in pure water. If the soil solution contains more hydrogen ions than are found in pure water, the soil is considered acid; if less it is considered alkaline. The hydrogen ion concentration is expressed in terms of pH values. The pH of pure water is 7 or neutral. Lower pH values indicate acidity and higher pH values indicate alkalinity. Soil pH values can range between the extremes of 2 and 10. Depending on past management practices, soil pH values of 4.5 to 7 are typical for New Jersey.

Table 1. Recommended amount of calcium carbonate (CaCO3) to achieve a pH of 6.3-6.5 based on soil texture and existing soil pH value.

	SOIL TEXTURE			
	Loamy Sand	Sandy Loam	Loam	Silt Loam
Existing Soil pH	lbs. /1000 sq. ft.			
4.1 to 4.4	115	155	240	300
4.5 to 4.8	95	125	200	250
4.9 to 5.2	70	95	160	200
5.3 to 5.6	45	65	120	150
5.7 to 6.0	25	35	60	100

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Soil Acidity Lime Requirement

The pH value of a soil is a measure of the active hydrogen ions in a soil-water mixture. This pH value does not measure the "reserve" or "latent" acidity of an acid soil. Soils high in clay or organic matter will have greater "reserve" acidity than sandy soils. Years of experience and experimentation have yielded tables set up for various soil textures and their existing pH values. Table 1 gives the lime requirement needed to reach a desired pH value for various soil textures. Limestone should not be at rates greater than 50 lbs./ 1000 ft2 in a single application to established turf.

Liming Materials

The most common material used to correct soil acidity is limestone in a pulverized, burned, or hydrated form. These materials are composed of calcium and/or magnesium in the form of carbonate, oxide, or hydroxide as the acid-neutralizing elements. Dolomitic limestone contains both calcium and magnesium. A pure dolomitic limestone has a calcium:magnesium ratio of approximately 3:2.

Pulverized limestone is by far the most common form of liming material. Burned and hydrated lime provide a more rapid effect than pulverized limestone and less material is needed for the same acid-neutralizing effect. Burned and hydrated lime are not commonly used on turf and are generally not recommended because of their caustic properties. Pulverized limestone is frequently sold in pelletized form. Pelletized lime eliminates the "dustiness" of pulverized lime.

Fineness of Pulverized Lime

The rate of reaction of limestone with soil acids is largely determined by the particle size of the limestone. The finer the particle or granule, the greater the surface area of the limestone that is exposed to the soil solution. For a quick change in soil pH, limestone particles which pass a 100-mesh screen are needed. Limestone particles which pass between a 20-mesh and 100-mesh screen size react within a year or so. Limestone particles between 20- and 100-mesh screen size are generally best suited for liming turf. Particles larger than 20-mesh are very slow to react and are not suitable for liming turfgrass. It is very important to use very fine dolomitic limestone because of its low solubility.

Effective Neutralizing Value

The effective neutralizing value (ENV) of a liming material is based on its calcium carbonate (CaCO3) equivalent value with the standard equal to 1.0. Dolomitic limestone has a higher effective neutralizing value because the ENV of MgCO3 is 1.19 times greater than CaCO3. Burnt lime (CaO) is 1.79 times the ENV of limestone and 1.35 times the ENV of hydrated lime (Ca(OH)2).

Incorporation of Lime

The depth and rate of penetration of liming materials from surface application is dependent on the type of material used, amount added, rainfall, soil texture, and organic matter content. Generally, liming materials added to the soil surface move very slowly to lower depths. For this reason, correction of soil acidity below the soil surface is best achieved by incorporating liming materials into the soil before establishment of the turf.

If soil acidity is not corrected before establishment, deep root extension and development of grasses will be inhibited. When a turf does not fully extend its root system, it will be prone to water stress and require frequent watering during periods of drought. A shallow rooted turf may also be prone to nutrient deficiencies.

Once soil acidity is corrected, maintenance applications of a liming material are needed every 2 to 3 years on sandy soils and 3 to 4 years on finer textured soils. The need for reliming will depend on the kind of soil, rainfall, type of fertilizer used, and whether grass clippings are or are not removed. Monitoring of soil pH should be done every 1 to 3 years along with soil nutrient testing

once soil pH has been corrected. See Fact Sheet 633, "Fertilizing the Home Lawn," for additional information regarding fertilization.

Soil pH Range for Turfgrass

The optimum pH range for most turfgrass species is 5.0 to 7.0 and it varies according to the species or variety of turfgrass. Differences in pH tolerance among varieties within a given turfgrass exist and there is potential to develop more lowpH tolerant varieties. Below is a table of soil pH ranges desirable for the culture of many turfgrasses grown in New Jersey.

Turfgrass Species	*pH range*
Sheep Fescue	5.0–6.0
Redtop	5.0–6.0
Velvet Bentgrass	5.0–6.0
Hard Fescue	5.0–6.5
Chewings Fescue	5.0–6.5
Creeping Red Fescues	5.5–6.5
Creeping & Colonial Bentgrass	5.5–6.5
Perennial Ryegrass	5.5–7.0
Tall Fescue	5.5–7.0
Annual Bluegrass	6.0–6.5
Kentucky Bluegrass	6.0–6.5
Canada Bluegrass	6.0–6.5
Rough Bluegrass	6.0–7.0
Bermudagrass	6.0–7.0
Zoysiagrass	6.0–7.0

Recent research indicates that acid soil pH values (6.0–6.2) can be helpful in culturally controlling the root infecting disease, summer patch. Soil pH levels above the low 6's appear to enhance summer patch disease development. For this reason, annual bluegrass and Kentucky bluegrass turfs should be limed only when pH values drop below 6.0. Liming rates should be limited to correction of the pH to values not exceeding 6.5 to avoid enhancing the severity of summer patch.

Alkaline Soil pH

In recent years, soil test results at the Rutgers Soil Testing Laboratory indicate soil pH values have become alkaline at many sites across the state. Soil pH values above 7.0 can hinder turfgrass performance for many reasons. Kentucky bluegrass, annual bluegrass, and likely the fine fescues all become more susceptible to summer patch disease at high soil pH values. Most of the plant essential micronutrients become less available at high pH values. Phosphorus availability is limited at pH values above 7.5. These nutrient deficiencies may be most acute on sandy soils where nutrient content is inherently low. Soil pH values above neutrality may also adversely affect soil microbial processes that are favored by slightly acidic soil conditions. Reasons for alkaline soil conditions in this region of the country are overliming, the use of irrigation water having a high pH, and topdressing with materials containing a relatively large amount of limestone. Irrigation water having a high pH may be originating from a limestone bedrock or aquifer.

Lowering Soil pH

Many materials are available which will make soil more acid. Nitrogen fertilizers are the best known materials which alter soil reaction. Some fertilizers increase acidity and others de- crease acidity. Fertilizers containing ammonium sulfate, ammonium nitrate, ammonium phosphates and urea will acidify the soil. Ammonium sulfate has the strongest acidifying effect of these nitrogen sources. Fertilizers containing calcium cyanamide, sodium, potassium or calcium nitrate, and bone meal make the soil less acid. The latter fertilizers should be avoided if alkaline soil conditions have developed and there is a need to lower the soil pH.

Use of nitrogen fertilizers that acidify the soil may not alter the soil pH greatly in a single season especially on soils having a high clay or organic matter content. Where a more rapid decrease in soil pH is desired, the use of other materials may be necessary. The table below lists materials that can be used to decrease soil pH. Of these materials, sulfur is the most popular because of its greater acidifying capability per pound of material. All other materials require significantly larger amounts to achieve similar reductions in soil pH.

As with lime, sulfur additions incorporated into the soil prior to establishment of a turf provides the most effective correction of soil pH. Surface applications require more time and rainfall to work deeper into the soil profile. A single surface application rate of sulfur on established turf should not exceed 1 pound sulfur per 1000 sq. ft, unless it is watered in. In this case 2 pounds per 1000 sq. ft. may be used. Rates exceeding this can cause significant "burning" as a result of intense localized acidification zones in the soil and/or thatch. Annual application of up to 3 pounds sulfur per 1000 sq. ft. have been used successfully when split into 3 to 5 applications during the year. Applications of sulfur are generally free of burning during the fall and spring when rainfall is sufficient to work the sulfur into the soil. Use of coarse sulfur particles should be avoided because of the burning of turf that occurs around those coarse particles that do not disperse quickly and move into the soil. When attempting to lower pH, regular soil testing should be performed to avoid an excessive decrease in pH in the soil surface 1 to 2 inches. Soil samples during this time should be taken from the surface 1 to 2 inches with an additional sample from the 2 to 6 inch zone. These samples, from two depths, will indicate whether the acidification program is too aggressive or proceeding at an acceptable rate. Portable pH meters can be used to follow the course of soil pH changes (see fact sheet, FS767, *Soil pH Measurement with a Portable Meter*).

Weight of other acidifying amendments required to equal 1 pound of sulfur

Amendment	Equivalent to 1 lb sulfur (lb)
Lime-sulfur solution (CaS2)	4.2
Sulfuric acid	3.1
Iron sulfate (Fe SO4 . 7H2O)	8.7
Aluminum sulfate (Al2(SO4)3 . 18H2O)	7.0

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